# Notice No.4

## Rules and Regulations for the Classification of Ships, July 2018

The status of this Rule set is amended as shown and is now to be read in conjunction with this and prior Notices. Any corrigenda included in the Notice are effective immediately.

Please note that corrigenda amends to paragraphs, Tables and Figures are not shown in their entirety.

### Issue date: November 2018

| Amendments to | Effective date | IACS/IMO implementation (if applicable) |
|---|---|---|
| Part 5, Chapter 1, Sections 1 & 3 | 1 January 2019 | N/A |
| Part 5, Chapter 2, Sections 2 & 13 | 1 January 2019 | N/A |
| Part 5, Chapter 10, Sections 1, 10, 12 & 15 | 1 January 2019 | N/A |
| Part 5, Chapter 11, Sections 1 & 10 | 1 January 2019 | N/A |
| Part 5, Chapter 12, Sections 1 & 5 | 1 January 2019 | N/A |
| Part 5, Chapter 14, Section 2 | 1 January 2019 | N/A |
| Part 6, Chapter 2, Section 10 | 1 January 2019 | 1 January 2019 |
| Part 6, Chapter 3, Sections 2 & 4 | 1 January 2019 | N/A |

# Part 5, Chapter 1
# General Requirements for the Design and Construction of Machinery

## ■ *Section 1*
## General

### 1.3 Alternative approach for product assurance

1.3.3 Where manufacturers are approved by LR under an alternative approach for product assurance (e.g. QAM, MQS, PVS), the intervention arrangements agreed under the scheme shall ensure that the relevant Rule requirements and corresponding certification requirements are met.

## ■ *Section 3*
## Operating conditions

### 3.4 Definitions

3.4.4 Pressure gauges may be calibrated in ~~bar~~ MPa, where:

1 MPa = 10 bar = ~~0,~~1 N/mm$^2$ = ~~1,02~~ 10,2 kgf/cm$^2$.

# Part 5, Chapter 2
# Reciprocating Internal Combustion Engines

## ■ *Section 2*
## Materials and Components

### 2.2 Testing and inspection

2.2.1 ~~Except where *Pt 5, Ch 2, 2.2 Testing and inspection 2.2.3* applies, m~~Materials and components for engines are to be manufactured~~, and~~ tested and documented in accordance with the relevant requirements of the *Rules for the Manufacture, Testing and Certification of Materials, July 2018* and *Table 2.2.1 Summary of testing and associated documentation for engine components*.

~~2.2.3~~ 2.2.2 Where an ~~alternative approach for product assurance has been approved by~~ LR quality scheme is in place (*see Pt 5, Ch 1, 1.3 Alternative approach for product assurance*)~~:~~ , the testing and documentation requirements in *Table 2.2.1 Summary of testing and associated documentation for engine components* will be in accordance with a specific LR quality scheme certification schedule identifying the tests, intervention requirements and associated documentation including types of certificates that are to be issued.

~~(a) Testing and inspection identified as requiring LR engagement in *Table 2.2.1 Summary of testing and associated documentation for engine components* may be carried out and documented by the manufacturer in accordance with the approved alternative approach for product assurance.~~

~~(b) Any agreed variation to the requirements given in *Table 2.2.1 Summary* of testing and associated documentation for engine components is to be included within the alternative approach for product assurance scheme certification schedule.~~

~~2.2.2~~ 2.2.3 ~~All~~ The testing and inspection in *Table 2.2.1 Summary of testing and associated documentation for engine components* is to be documented by ~~manufacturer's certificate~~ the manufacturer (e.g. manufacturer certified materials testing or manufacturer issued NDT report as applicable)~~, *see Pt 5, Ch 2, 2.2 Testing and inspection 2.2.8*~~ except where LR ~~engagement~~ intervention is explicitly required.

~~2.2.6~~ 2.2.5 The manufacturer is not exempted from responsibility for any relevant tests and inspections of those parts for which documentation is not explicitly requested by LR.

~~2.2.7~~ 2.2.6 Where *Table 2.2.1 Summary of testing and associated documentation for engine components* states that a test report is required, this is to be issued by the manufacturer and provided for review by the Surveyor. The report is to identify the samples from current production that have been tested and inspected to confirm that the component complies with all applicable requirements.

~~2.2.8~~ 2.2.7 Where a manufacturer's ~~certificate~~ document (test certificate or NDT report) is required in *Table 2.2.1 Summary of testing and associated documentation for engine components*, this is to be issued by the manufacturer and provided for review by the Surveyor. The ~~certificate~~ document is to comply with the requirements of the *Rules for the Manufacture, Testing and Certification of Materials, July 2018, Ch 1, 3.1 General 3.1.3-(c)* or *Ch 1, 5.5 Non-destructive examination reports 5.5.1* as applicable.

~~2.2.5~~ 2.2.8 Components and materials not specified in *Table 2.2.1 Summary of testing and associated documentation for engine components* or of novel design will be specially considered upon submission of their details.

**Table 2.2.1 Summary of testing and associated documentation for engine components**

| Part | Material properties *see* Note 2 | Non-destructive examination | Hydraulic testing *see* Note 4 | Dimensional inspection *see* Note 3 | Visual inspection ~~*see* Note 5~~ | Applicable to engines | Final document to be issued |
|---|---|---|---|---|---|---|---|
| Welded bedplate | ~~C + LR(M)~~ W (C + M) | ~~UT + CD~~ W (UT + CD) | - | - | LR (V) fit-up + post-welding | All | LR Component Certificate |
| Bearing transverse girders (cast steel) | ~~C + LR(M)~~ W (C + M) | ~~UT + LR(CD)~~ W (UT + CD) | - | - | LR(V) | All | LR Component Certificate |
| Welded frame box *see* Note ~~6~~5 | ~~C + LR(M)~~ W (C + M) | ~~UT + CD~~ W (UT + CD) | - | - | LR(V) fit-up + post-welding | All | LR Component Certificate |
| Cylinder block (~~cast iron~~ grey cast iron or spheroidal graphite cast iron) | ~~LR(M)~~ - | - | ~~LR~~ W (P) *see* Note ~~7~~6 | - | - | Crosshead | W Hydraulic Test Certificate |
| Welded cylinder frames *see* Note ~~6~~5 | ~~C + LR(M)~~ W (C + M) | ~~UT + CD~~ W (UT + CD) | - | - | LR(V) fit-up + post-welding | Crosshead | LR Component Certificate |
| Engine block (grey cast iron) | ~~LR(M)~~ - | - | ~~LR~~ W (P) *see* Note ~~7~~6 | - | - | >400kW/cylinder | W Hydraulic Test Certificate |
| Engine block (spheroidal graphite cast iron) | W (M) | | W (P) *see* Note 6 | | | >400kW/cylinder | W Material Properties Certificate<br><br>W Hydraulic Test Certificate |
| Cylinder liner | ~~C + LR(M)~~ W (C+ M) | - | ~~LR~~ W (P) *see* Note ~~7~~6 | - | - | B>300mm | W Material Properties Certificate<br><br>W Hydraulic Test Certificate |
| Cylinder head (~~cast iron~~ grey cast iron or spheroidal graphite cast iron) | ~~LR(M)~~ - | - | ~~LR~~ W (P) | - | - | B>300mm | W Hydraulic Test Certificate |
| Cylinder head (cast steel) | ~~C + LR(M)~~ W (C + M) | ~~UT + LR(CD)~~ W (UT + CD) | ~~LR~~ W (P) | - | LR(V) | B>300mm | LR Component Certificate |
| Cylinder head (forged) | ~~C + LR(M)~~ W (C + M) | ~~UT + LR(CD)~~ W (UT + CD) | ~~LR~~ W (P) | - | LR(V) | B>300mm | LR Component Certificate |
| Piston crown (cast steel) ~~*see* Note 9~~ | ~~C + LR(M)~~ W (C + M) | ~~UT + LR(CD)~~ W (UT + CD) | - | - | LR(V) | B>400mm | LR Component Certificate |
| Piston crown (forged) | ~~C + LR(M)~~ W (C+ M) | ~~UT + LR(CD)~~ W (UT + CD) | - | - | LR(V) | B>400mm | LR Component Certificate |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Crankshaft (one piece) | LR(C + M) | ~~UT + LR(CD)~~ W (UT + CD) | - | ~~D~~ W | LR(V) (Random, of fillets and oil bores) | All | LR Component Certificate |
| Semi-built crankshaft (~~C~~crankthrow, forged main journal and journals with flange) | LR(C + M) | ~~UT + LR(CD)~~ W (UT + CD) | - | ~~D~~ W | LR(V) (Random, of fillets and shrink fittings) | All | LR Component Certificate |
| Exhaust gas valve cage | ~~LR(M)~~ - | - | ~~LR~~ W (P) | - | - | Crosshead | W Hydraulic Test Certificate |
| Piston rod | LR(C + M) | ~~UT + (CD)~~ W (UT + CD) | - | - | LR(V) (Random) | B>400mm | LR Component Certificate |
| Crosshead pin | LR(C + M) | ~~UT + (CD)~~ W (UT + CD) | - | - | LR(V) (Random) | Crosshead | LR Component Certificate |
| Connecting rod with cap | LR(C + M) | ~~UT + LR(CD)~~ W (UT + CD) | - | ~~D~~ W | LR(V) (Random, of all surfaces in particular those shot peened) | All | LR Component Certificate |
| Crankshaft coupling bolts | LR(C + M) | ~~UT + CD~~ W (UT + CD) | - | ~~D~~ W | LR(V) (Random, of interference fit) | All | LR Component Certificate |
| Bolts and studs for cylinder heads, crossheads, main bearings and connecting rods *see* Note ~~10~~9 | ~~C + LR(M)~~ W (C + M) | ~~UT + CD~~ W (UT + CD) | - | TR [thread making for connecting rods] | - | B>300mm | W Material Properties Certificate<br><br>W Non-Destructive Examination Report<br><br>W Test Report |
| Tie rod *see* Note ~~11~~10 | ~~C + LR(M)~~ W (C + M) | ~~UT + CD~~ W (UT + CD) | - | TR [thread making] | LR(V) (Random) | Crosshead | LR Component Certificate |
| High pressure fuel injection system – valve and pump body (pressure side) *see* Notes ~~12, 13,~~ 11 and 12 ~~14 and 15~~ | LR(C + M) *see* Note 8 | - | ~~LR~~ W (Lesser of P or *p*+30 MPa) | - | - | ~~All~~ B>300mm | LR Component Certificate<br><br>*see* Note 8 |
| | | | TR (Lesser of ~~*P*~~ P or *p*+30 MPa) | | | B≤300mm | |
| High pressure fuel injection pipes including common rail *see* Note~~s~~ ~~12~~11, ~~14 and 15~~ | LR(C + M) *see* Note 8 | - | ~~LR~~ W (Lesser of P or *p*+30 MPa) | - | - | ~~All~~ B>300mm | LR Component Certificate<br><br>*see* Note 8 |
| | | | TR (Lesser of ~~*P*~~ P or *p*+30 MPa) | | | B≤300mm | |
| High pressure common servo oil system ~~*see* Notes 14 and 15~~ | LR(C + M) *see* Note 8 | - | ~~LR~~ W (Lesser of P or *p*+30 MPa) | - | - | ~~All~~ B>300mm | LR Component Certificate<br><br>*see* Note 8 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| | | | TR (Lesser of ~~*P*~~ P or *p*+30 MPa) | | | B≤300mm | |
| Coolers, both sides *see* Note~~s 14 and 16~~13 | LR(C + M) *see* Note 8 | - | ~~LR~~ W (P) | - | - | B>300mm | LR Component Certificate<br>*see* Note 8 |
| Accumulator of common rail fuel or servo oil system ~~*see* Note 14~~ | LR(C + M) *see* Note 8 | - | ~~LR~~ W (Lesser of ~~*P*~~ P or *p*+30 MPa) | - | - | Accumulators with a capacity >0,5l | LR Component Certificate<br>*see* Note 8 |
| Piping, pumps, actuators, etc., for hydraulic drive of valves, if applicable ~~*see* Note 14~~ | LR(C + M) *see* Note 8 | - | ~~LR~~ W (P) | - | - | >800kW/cylinder | LR Component Certificate<br>*see* Note 8 |
| Engine-driven pumps (oil, water, fuel, bilge) ~~*see* Note 14~~ | LR(C + M) *see* Note 8 | - | ~~LR~~ W (P) | - | - | >800kW/cylinder | LR Component Certificate<br>*see* Note 8 |
| Bearings (main, crosshead, and crankpin) *see* Note ~~17~~14 | TR [C] | TR [UT] | - | ~~D~~<br>W | ~~LR(V)~~<br>- | >800kW/cylinder | TR Material Properties<br>TR Non-Destructive Examination Report<br>W Inspection Certificate |

SYMBOLS:

| | |
|---|---|
| B = Bore dimension, refers to engine cylinder bores | *p* = Maximum working pressure of item concerned |
| C = Chemical composition analysis | P = Pressure test at 1,5*p* |
| M = Mechanical property analysis | V = Visual examination of accessible surfaces |
| UT = Ultrasonic testing (*see* Note 1) | LR ( ) = Test/inspection to be certified by LR ~~except where *Pt 5, Ch 2, 2.2 Testing and inspection 2.2.5 applies*~~. |
| CD = Crack detection by MPI or DPT (*see* Note ~~8~~7) | TR[ ] = Test report required for process in brackets (*see Pt 5, Ch 2, 2.2 Testing and inspection ~~2.2.7~~ 2.2.6*) |
| ~~D = Dimensional inspection, including surface condition~~<br>W ( ) = Test/inspection to be certified by manufacturer | |

Note 1. Ultrasonic testing is not required for components manufactured from cast iron.

Note 2. Material properties include chemical composition and mechanical properties, as identified in the table above. Where mechanical testing is required this is to include testing of surface treatment, such as surface hardening (hardness, depth and extent), peening and rolling (extent and applied force) as applicable. Mechanical tests are to be conducted after the final heat treatment has been applied.

Note 3. Dimensional inspection, ~~is to~~ include~~i~~ng assessment of surface condition.

Note 4. Hydraulic testing is applied on the water/oil side of the component. The full lengths of cooling spaces are to be tested, where applicable. Where design or testing features may require modification of these test requirements, special consideration may be given.

~~Note 5. Certificates issued for visual inspection, either following satisfactory survey or under an approved LR Quality Scheme, are to be considered as component certificates~~

Note ~~6~~5. Where welding is carried out, welding and welder qualifications are to be carried out in accordance with the *Rules for the Manufacture, Testing and Certification of Materials, July 2018, Ch 12 Welding Qualifications*.

Note ~~7~~6. Hydraulic testing is also required for those parts filled with cooling water and having the function of containing the water which is in contact with the cylinder or cylinder liner.

Note ~~8~~7. Magnetic particle testing is to be carried out on ferro-magnetic materials, penetrant testing is only to be carried out on non-ferritic materials. Visual examination alone is ~~not~~ considered insufficient. Magnetic particle and dye penetrant testing are to be carried out when the forgings are in the finished machined condition.

Note ~~9~~8. ~~Where the piston rod seals the piston crown cooling space, it is to be tested after assembly.~~ Where piping systems and components are categorised as Class III, the testing for material properties shall be W(C + M) as a minimum. For materials documentation requirements, *see Pt 5, Ch 12, 1.7 Materials.* W Hydraulic Test Certificate or Test Report will also form as part of Final Document to be Issued.

| |
|---|
| Note ~~10~~9. *See also Rules for the Manufacture, Testing and Certification of Materials, July 2018, Ch 5, 3.5 Non-destructive examination 3.5.1* for detailed non-destructive examination requirements for other bolts and studs. |
| Note ~~11~~10. Magnetic particle testing of tie rods may be confined to the threaded portions and the adjacent material over a length equal to that of the thread. |
| Note ~~12~~11. Where components are subjected to an autofrettage process accepted by LR (*see Pt 5, Ch 2, 2.4 Autofrettage*), the component pressure test may be omitted. The assembled system containing such components is to be shown, where practicable, to be pressure-tight as required for hydraulic systems. |
| Note ~~13~~12. Pumps used in jerk or timed pump systems only need to have the assembled high pressure containing components hydraulically tested. |
| ~~Note 14. *See also Pt 5, Ch 2, 8 Piping*. Material certification requirements for pumps and piping components are dependent on the operating pressure and temperature. Requirements given in this Table apply except where alternative requirements are explicitly given in *Pt 5, Ch 12 Piping Design Requirements* and *Pt 5, Ch 14 Machinery Piping Systems*.~~ |
| ~~Note 15.Where an alternative approach for product assurance approved by LR is in operation, components for engines with a bore of 300mm or less may be supplied with test reports (as described in *Pt 5, Ch 2, 2.2 Testing and inspection 2.2.7*) instead of test certificates for pressure testing and materials tests, *see Pt 5, Ch 2, 2.2 Testing and inspection 2.2.3.*~~ |
| Note ~~16~~13. Material and component certification for accumulators or coolers which are classed as pressure vessels are dependent on the operating pressure and temperature, *see Pt 5, Ch 11, 1.5 Classification of fusion welded pressure vessels* and *Pt 5, Ch 11, 1.7 Materials*. Charge air coolers are only to be tested on the water side. |
| Note ~~17~~14. Ultrasonic testing is required to prove full adhesion between ~~basic~~ base material and bearing metal. |
| Note ~~18~~15. ~~Magnetic particle testing is to be carried out on ferro-magnetic materials, penetrant testing is only to be carried out on non-ferritic materials. Visual examination alone is not considered sufficient.~~ |

■ *Section 13*

# Air compressors

## 13.4 Design and Construction

*(Part only shown)*

13.4.2 The diameter, $d_p$, of a compressor crankshaft is to be not less than *d*, determined by the following formula, when all cranks on the shaft are located between two main bearings only:

$$d = V_c \left( \frac{10 D^2 p Z}{78{,}5} \left( \frac{S}{16} + \frac{ab}{a+b} \right) \right)^{1/3} \text{ mm}$$

***p*** = design pressure, in ~~bar~~ MPa g, as defined in *Pt 5, Ch 12, 1.3 Design symbols 1.3.1*

## 13.7 Crankcase relief valves

13.7.2 Crankcases are to be provided with lightweight spring-loaded valves or other quick-acting and self-closing devices to relieve the crankcases of pressure in the event of an internal explosion and to prevent any inrush of air thereafter. The valves are to be designed and constructed to open quickly and be fully open at a pressure not greater than ~~0,2 bar~~ 0,02 MPa.

# Part 5, Chapter 10
# Steam Raising Plant and Associated Pressure Vessels

## ■ *Section 1*
## General requirements

### 1.2 Definition of symbols

*(Part only shown)*

1.2.1 The symbols used in the various formulae in *Pt 5, Ch 10, 2 Cylindrical shells and drums subject to internal pressure* to *Pt 5, Ch 10, 8 Headers*, unless otherwise stated, are defined as follows and are applicable to the specific part of the pressure vessel under consideration:

***p*** = design pressure, *see Pt 5, Ch 11, 1.3 Design pressure*, in ~~bar~~ MPa

### 1.5 Classification of fusion welded pressure vessels

1.5.1 For Rule purposes, pressure vessels with fusion welded seams are graded as Class 1 if they comply with the following conditions:

(a) For pressure parts of fired steam boilers, fired thermal liquid heaters and exhaust gas heated shell type steam boilers where the design pressure exceeds ~~3,4 bar~~ 0,34 MPa.

(b) For pressure parts of steam heated steam generators and separate steam receivers where the design pressure exceeds ~~11,3 bar~~ 1,13 MPa, or where the pressure, in ~~bar~~ MPa, multiplied by the internal diameter of the shell, in mm, exceeds ~~14 420~~ 1442.

## ■ *Section 10*
## Flat plates and ends of vertical boilers

### 10.1 Tube plates of vertical boilers

*(Part only shown)*

10.1.1 Where vertical boilers have a nest or nests of horizontal tubes, so that there is direct tension on the tube plates due to the vertical load on the boiler ends or to their acting as horizontal ties across the shell, the thickness of the tube plates in way of the outer rows of tubes is to be determined by the following formula:

$$t = \frac{2pD}{\text{~~5~~}JR_{20}} + 0{,}75 \text{ mm}$$

= where *t* and *p* are as defined in *Pt 5, Ch 10, 1.2 Definition of symbols*

### 10.2 Horizontal shelves of tube plates forming part of the shell

*(Part only shown)*

10.2.1 For vertical boilers of the type referred to in *Pt 5, Ch 10, 10.1 Tube plates of vertical boilers*, in order to withstand vertical load due to pressure on the boiler ends, the horizontal shelves of the tube plates are to be supported by gussets in accordance with the following formula:

$$C = \frac{10AD_{\text{i}}p}{t}$$

***p*** = design pressure, in ~~bar~~ MPa

### 10.3 Dished and flanged ends for vertical boilers

10.3.1 The minimum thickness, *t*, of dished and flanged ends for vertical boilers which are subject to pressure on the concave side and are supported by central uptakes is to be determined by the following formula:

$$t = \frac{10pR_{\text{i}}}{13\sigma} + 0{,}75 \text{ mm}$$

where

= *t*, *p*, $R_{\text{i}}$ and σ are as defined in *Pt 5, Ch 10, 1.2 Definition of symbols*.

## ■ *Section 12*
## Boiler tubes subject to external pressure

### 12.1 Tubes

12.1.1 The thickness of tubes is to be in accordance with *Table 10.12.1 Thickness of plain tubes under external pressure* for the appropriate outside diameter and design pressure.

*Existing Table 10.12.1 has been deleted and replaced with the following.*

**Table 10.12.1 Thickness of plain tubes under external pressure**

| Outside diameter, in mm | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 38 | 44,5 | 51 | 57 | 63,5 | 70 | 76 | 82,5 | 89 | 95 | 102 | Thickness, in mm |
| Design pressure, in MPa | | | | | | | | | | | |
| – | – | – | – | – | – | – | – | – | 2,69 | 2,52 | 5,89 |
| – | – | – | – | – | – | – | 2,62 | 2,41 | 2,28 | 2,14 | 5,38 |
| – | – | – | – | – | – | 2,41 | 2,21 | 2,07 | 1,93 | 1,79 | 4,88 |
| – | – | – | 2,76 | 2,48 | 2,28 | 2,07 | 1,93 | 1,79 | 1,66 | 1,59 | 4,47 |
| – | 2,93 | 2,55 | 2,28 | 2,07 | 1,89 | 1,73 | 1,59 | 1,48 | 1,37 | 1,27 | 4,06 |
| 2,66 | 2,28 | 2,07 | 1,79 | 1,59 | 1,48 | 1,31 | 1,24 | 1,14 | 1,03 | 0,96 | 3,66 |
| 2,03 | 1,69 | 1,48 | 1,31 | 1,21 | 1,10 | 0,96 | 0,89 | 0,82 | 0,76 | 0,69 | 3,25 |
| 1,48 | 1,24 | 1,07 | 0,96 | 0,86 | 0,76 | – | – | – | – | – | 2,95 |

## ■ *Section 15*
## Mountings and fittings for cylindrical and vertical boilers, steam generators, pressurised thermal liquid and pressurised hot water heaters

### 15.1 General

15.1.4 Safety valve chests and other boiler and superheater mountings subjected to pressures exceeding ~~13,0 bar~~ 1,3 MPa or to steam temperatures exceeding 220°C, and boiler blow-down fittings, are to be made of steel or other approved material.

### 15.2 Safety valves

*(Part only shown)*

15.2.11 The designed discharge capacities of the safety valves on each boiler and steam generator are to be found from the following formulae:

Saturated steam safety valves:

$$E = \frac{AC\ (10p + 1{,}03)}{98{,}1}$$

Superheated steam safety valves:

$$E = \frac{AC\ (10p + 1{,}03)}{98{,}1} \sqrt{\frac{V_s}{V_H}}$$

**where**

***p*** = set pressure, in ~~bar~~ MPa gauge

### 15.3 Waste steam pipes

15.3.4 The scantlings of waste steam pipes and silencers are to be suitable for the maximum pressure to which the pipes may be subjected in service, and in any case not less than ~~10 bar~~ 1 MPa.

# Part 5, Chapter 11
# Other Pressure Vessels

## ■ *Section 1*
## General requirements

### 1.2 Definition of symbols

*(Part only shown)*

1.2.1 The symbols used in the various formulae in *Pt 5, Ch 11, 2 Cylindrical shells and drums subject to internal pressure* to *Pt 5, Ch 11, 7 Standpipes and branches* inclusive, unless otherwise stated, are defined as follows, and are applicable to the specific part of the pressure vessel under consideration:

***p*** = design pressure, *see Pt 5, Ch 11, 1.3 Design pressure*, in ~~bar~~ MPa

### 1.5 Classification of fusion welded pressure vessels

*(Part only shown)*

1.5.2 For Rule purposes, pressure vessels are graded as Class 2/1 and Class 2/2 if they comply with the following conditions:

(a) where the design pressure exceeds ~~17,2 bar~~ 1,72 MPa, or

(b) where the metal temperature exceeds 150°C, or

(c) where the design pressure, in ~~bar~~ MPa, multiplied by the actual thickness of the shell, in mm, exceeds ~~157~~ 15,7, or

### 1.6 Plans

1.6.1 Plans of pressure vessels are to be submitted in triplicate for consideration where all the conditions in *Pt 5, Ch 11, 1.6 Plans 1.6.1* or *Pt 5, Ch 11, 1.6 Plans 1.6.1.(b)* are satisfied:

(a) The vessel contains vapours or gases, e.g. air receivers, hydrophore or similar vessels and gaseous $CO_2$ vessels for fire-fighting, and

*pV* > ~~600~~ 60
*p* > ~~1~~ 0,1
*V* > 100
*V* = volume (litres) of gas or vapour space

(b) The vessel contains liquefied gases for fire-fighting or flammable liquids, and
*p* > ~~7~~ 0,7
*V* > 100
*V* = volume (litres)
*p* is as defined in *Pt 5, Ch 9, 1.2 Definition of symbols 1.2.1*.

## ■ *Section 10*
## Hydraulic tests

### 10.1 General

*(Part only shown)*

10.1.1 Pressure vessels covered by this Chapter are to be tested on completion to a pressure, $p_T$, determined by the following formula, without showing signs of weakness or defect:

$$p_T = \text{~~1,3~~ } 0{,}13 \frac{\sigma_{50} t}{\sigma_T (t - 0{,}75)} p$$

= but in no case is to exceed

$$\text{~~1,5~~ } 0{,}15 \frac{t}{(t - 0{,}75)} p$$

where

***p*** = design pressure, in ~~bar~~ MPa

***p*$_T$** = test pressure, in ~~bar~~ MPa

# Part 5, Chapter 12
# Piping Design Requirements

## ■ *Section 1*
## General

### 1.3 Design symbols

*(Part only shown)*

1.3.1 The symbols used in this Chapter are defined as follows:

***p*** = design pressure, in ~~bar (kgf/cm²)~~ MPa, *see Pt 5, Ch 12, 1.4 Design pressure*

$p_{-t}$ = hydraulic test pressure, in ~~bar (kgf/cm²)~~ MPa

### 1.6 Classes of piping systems and components

**Table 12.1.1 Maximum pressure and temperature conditions for Class II and III piping systems**

| Piping system | Class II | | Class III | |
|---|---|---|---|---|
| | $P_2$ | $T_2$ | $P_1$ | $T_1$ |
| | ~~bar~~ MPa | °C | ~~bar~~ MPa | °C |
| Steam | ~~16,0~~ 1,6 | 300 | ~~7,0~~ 0,7 | 170 |
| Thermal oil | ~~16,0~~ 1,6 | 300 | ~~7,0~~ 0,7 | 150 |
| Flammable ~~L~~liquids, *see* Note 1 | ~~16,0~~ 1,6 | 150 | ~~7,0~~ 0,7 | 60 |
| Other media, *see* Note 2 | ~~40,0~~ 4 | 300 | ~~16,0~~ 1,6 | 200 |
| Cargo oil | ~~40,0~~ 4 | 300 | ~~16,0~~ 1,6 | 200 |
| Note *1.* Flammable liquids include~~;~~ fuel oil, lubricating oil and flammable hydraulic oil.<br><br>Note *2.* Including water, air, gases, non-flammable hydraulic oil. | | | | |

### 1.7 Materials

**Table 12.1.2 Maximum conditions for pipes, valves and fittings for which manufacturer's materials test certificate is acceptable**

| Material | *DN* = nominal diameter, mm<br>$p_{-w}$ = working pressure, ~~bar~~ MPa |
|---|---|
| When the working temperature is less than 300°C: Carbon and low alloy steel, austenitic stainless steel and cast iron (spheroidal or nodular) | *DN* < 50<br>or<br>$p_{-w} \times DN < 250$ |
| Copper alloy intended for a working temperature of less than 200°C | *DN* < 50<br>or<br>$p_{-w} \times DN < 150$ |

## ■ *Section 5*
## Plastic pipes

### 5.3 Design strength

5.3.2 The nominal internal pressure, $p_{Ni}$, of the pipe is to be determined by the lesser of the following:

~~$p_{Ni} \leq \frac{p_{st}}{4}$~~ $p_{Ni}$~~Pni~~ $\leq 2{,}5\ p_{st}$~~Pst~~

~~$p_{Ni} \leq \frac{p_{lt}}{4}$~~ $p_{Ni}$~~Pni~~ $\leq 4\ p_{lt}$~~Plt~~

**where**

$p_{st}$ = short term hydrostatic test failure pressure, in ~~bar~~ MPa

$p_{lt}$ = long term hydrostatic test failure pressure (100 000 hours), in ~~bar~~ MPa

Failure pressures obtained over a reduced period and extrapolated in accordance with a recognised National or International Standard will be specially considered.

5.3.4 The nominal external pressure, $p_{Ne}$, of the pipe, defined as the maximum total of internal vacuum and external static pressure head to which the pipe may be subjected, is to be determined by the following:

$$p_{Ne} \leq \frac{p_{col}}{3}$$

where

$p_{col}$ = pipe collapse pressure, in ~~bar~~ MPa

5.3.5 $p_{col}$ is not to be less than ~~3 bar~~ 0,3 MPa.

# Part 5, Chapter 14
# Machinery Piping Systems

## ■ *Section 2*
## Fuel oil - General requirements

### 2.2 Special fuels

2.2.2 For the burning of ~~methane~~ gas fuel in ~~methane~~ liquefied gas tankers/carriers, *see* the *Rules and Regulations for the Construction and Classification of Ships for the Carriage of Liquefied Gases in Bulk, July 2018* ~~Rules and Regulations for the Construction and Classification of Ships for the Carriage of Liquefied Gases in Bulk~~ (hereinafter referred to as the *Rules for Ships for Liquefied Gases* ~~Rules for Ships for Liquefied Gases~~).

2.2.3 Where it is proposed to use gas~~eous~~ fuel~~s~~ for main or auxiliary engines in ships other than ~~LNG carriers~~ given in the *Rules for and Regulations for the Construction and Classification of Ships for the Carriage of Liquefied Gases in Bulk, July 2018*, the relevant requirements of the *Rules and Regulations for the Classification of Ships using Gases or other Low-flashpoint Fuels* ~~Rules and Regulations for the Classification of Ships using Gases or other Low-flashpoint Fuels~~ are to be complied with. Full particulars of the proposed arrangements are to be submitted for special consideration. Attention is to be given to any relevant statutory requirements of the National Authority of the country in which the ships are to be registered.

# Part 6, Chapter 2
# Electrical Engineering

## ■ *Section 10*
## Converter equipment

### 10.1 Transformers

10.1.11 When oil-immersed transformers are used, there is to be monitoring for low oil level with an alarm when pre-set limits are crossed. There are to be arrangements so that the load may be reduced to a level commensurate with the cooling available.

*Existing paragraphs 10.1.11 to 10.1.13 have been renumbered 10.1.12 to 10.11.14.*

# Part 6, Chapter 3
# Refrigerated Cargo Installations

## ■ *Section 2*
## Design criteria

### 2.5 Design pressures

2.5.5 Design pressures (~~bar~~ MPa g) applicable to refrigerants are to be not less than the values given in *Table 3.2.2 Pressure limits* when condensers are sea-water cooled. The design pressure for other refrigerants and condensing arrangements is to be agreed with LR.

**Table 3.2.2 Pressure limits**

| Refrigerant | Pressure (~~bar~~ MPa g) | |
|---|---|---|
| | High | Low |
| R-717 | ~~21,2~~ 2,12 | ~~17,2~~ 1,72 |
| R-22 | ~~20,6~~ 2,06 | ~~16,7~~ 1,67 |
| R-290 | ~~18,1~~ 1,81 | ~~14,7~~ 1,47 |
| R-600a | ~~6,4~~ 0,64 | ~~5,2~~ 0,52 |
| R-134a | ~~13,4~~ 1,34 | ~~10,9~~ 1,09 |
| R-407C | ~~23,5~~ 2,35 | ~~19,0~~ 1,90 |
| R-410A | ~~33,14~~ 3,314 | ~~29,9~~ 2,99 |
| R-507A | ~~25,3~~ 2,53 | ~~20,5~~ 2,05 |
| R-404A | ~~24,8~~ 2,48 | ~~20,1~~ 2,01 |
| R-744 | *See Pt 6, Ch 3, 2.5 Design pressures 2.5.6* | |

■ *Section 4*

# Refrigeration plant, pipes, valves and fittings

### 4.2 Reciprocating compressors

*(Part only shown)*

4.2.5 The diameter, *d*, of a compressor crankshaft using one of the refrigerants detailed in *Pt 6, Ch 3, 2.5 Design pressures*, is to be not less than that determined by the following formula, when all cranks are located between two main bearings:

~~$d = V_c = \left(\frac{D^2 pZ}{78{,}5}\left(\frac{S}{16} + \frac{ab}{a+b}\right)\right)$ 1/3 mm~~

$$d = V_c \left(\frac{D^2 pZ}{7{,}85}\left(\frac{S}{16} + \frac{ab}{a+b}\right)\right)^{1/3} \text{mm}$$

$p$ = design pressure, in ~~bar~~ MPa g, as defined in *Pt 6, Ch 3, 2.5 Design pressures*

### 4.15 Overpressure protection devices

*(Part only shown)*

4.15.19 The rated discharge capacity of a bursting disc discharging to atmosphere under critical flow conditions is to be determined by the following formula:

$$d = 85{,}75\sqrt{10\frac{C}{P}} \text{ mm}$$

### 4.21 Pressure testing at manufacturers' works

**Table 3.4.2 Test pressure**

| | | Test pressure, ~~bar~~ MPa g | |
|---|---|---|---|
| Component | | Strength test | Leakage test |
| 1. | Pressure vessels | *See Pt 5, Ch 11 Other Pressure Vessels* | 1,0*p* |
| 2. | Compressor cylinders/crankcase/casing | 1,5*p* | 1,0*p* |
| 3. | Valves & fittings | 2,0*p* | 1,0*p* |
| 4. | Pressure piping, fabricated headers, air coolers, etc. | 1,5*p* | 1,0*p* |
| Note *p* is the design pressure as defined in *Pt 6, Ch 3, 2.5 Design pressures*. | | | |

4.21.4 Components for use with a secondary refrigerant or cooling water are to be hydraulically tested to 1,5 times the design pressure, but in no case less than ~~3,5 bar~~ 0,35 MPa g.

### 4.22 Pressure test after installation on board ship

4.22.5 Secondary refrigerant piping welded in place is to be hydraulically tested to 1,5 times the design pressure, but in no case less than ~~3,5 bar~~ 0,35 MPa g.

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